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Taste Perception in School Children: Is There an Association with Dental Caries?

SUMMARY

Background/Aim: *Individuals make food choices based on a number of physiological, nutritional, environmental and socioeconomic factors but sensory qualities of food namely the taste has priority as the determinant in food selection. The purpose of the study is to evaluate sweet, salty, sour and bitter taste perceptions of school children and compare them in term of caries experience.* ***Material and Methods***: *Two hundred children aged from 6-13 were included in the study. The dental examinations of children were performed using DMF(T), DMF(S), df(t) and df(s) indices. Questionnaires were presented to parents to record the socioeconomic and educational levels, oral health knowledge, child's general health, oral health habits and fluoride exposure. Children rinsed sucrose (12g/L; 24g/L), sodium chloride (2g/L; 4g/L), citric acid (0,6g/L; 1,20g/L) and caffeine (0,27g/L; 0,54g/L) solutions randomly and the taste perception was recorded. Relationship between the taste perception and caries experience were evaluated.* ***Results***: *A significant correlation was found between 2 g/L of NaCl and age (p= 0,007, r= 0,178). When occlusal or approximal caries of the children aged from 6 to 9 were discriminated, the Spearman's test found a weak positive correlation between occlusal caries and higher sweet taste (24 g/L sucrose) (r= 0,232; p= 0,021) and a weak negative correlation between approximal caries and higher salty taste (4 g/L NaCl) (r= –0,225; p= 0,025).* ***Conclusions***: *Age should be considered in the assessment of taste perception of children. Additionally, there is a weak relationship between taste perceptions and dental caries. These data suggest that further studies need to focus on the effect of taste preferences on dental caries.*

Key words: Taste, Dental Caries, Sweet, Sour, Bitter, Salty

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Introduction

Dental caries has four basic causes: host (the tooth), substrate (carbohydrates), microorganisms, and time[1–4]. The determination of caries activity in children and the assessment of caries risk are important components while choosing the right preventive treatment and deciding on the treatment of dental caries [5,6]. Many factors have been assessed while determining the risk of dental caries. These parameters are caries experience, salivary flow rate, saliva buffering capacity, microbiological measurements such as *Mutans streptococci* (MS) and *Lactobacilli* (LB), brushing habits, oral hygiene, fluoride intake, cultural, socioeconomic and genetic factors[2,3,7,8].

Dietary habits such as how and when food and drink are consumed and the frequent consumption of sugars modify and increase the risk of tooth decay[9]. Individuals make food choices based on a number of physiological, nutritional, environmental and socioeconomic factors but sensory qualities of food namely the taste has priority as the determinant in food selection[10,11]. There are four basic tastes such as sweet, salty, sour and bitter tastes. The umami, which is known to be the protein (savory) taste is also accepted as basic in recent decades[12–15]. Taste studies on adults and children are mainly involved in food preferences, and in diseases like eating disorders, overweight, obesity, inflammatory diseases such as the infections of upper respiratory tract, asthma and recent cancer and immunity[16–19]. Studies focusing on the relationship between taste perception and dental caries are limited. It can be predicted that the taste sensitivity may lead the child to select or refuse the foods which may cause or prevent dental caries. Recent studies have reported that particularly PROP taste perception can be an independent variable for caries experience after all factors are controlled[20–22].

In this study, we examined the four basic taste perceptions (salty, sweet, bitter and sour) in a group of school children and evaluated whether any of the tastes measured could add valuable information to dental caries experience of those children. Our aim was based on the hypothesis that there is a relationship among sweet, salty, bitter and sour taste perception and caries experience.

Material and Methods

Subjects and study design

A cross-sectional survey of two hundred schoolchildren (99 boys and 101 girls) aged from 6-13 who visited the Pediatric Dentistry Department of Marmara University for initial oral examination was conducted. The study was commenced before any prevention/treatment was initiated, all participants were informed about the study design and then informed consent was obtained from parents. Ethical approval was obtained from the Ethics Committee of Marmara University and was in accordance with the 1964 Helsinki declaration and its later amendments (ID: 02.05.2013-18). Inclusion criteria for this trial were children aged 6-13 without any chronic disease and children who had no antibiotics and drug intake within the last month. The exclusion criteria were children with disabilities, children with fixed orthodontic appliances, children for whom informed consent was not obtained from parents, children with a disease that effect their taste judgement[23].

Sample size calculation

The sample size was calculated according to the pilot study we have done before. When the number of samples was increased, with the power equal to 0,80 and alpha equal to 0.05, the calculation with G Power[24] indicated that 165 children would be required to obtain a sufficient evaluation.

Clinical examination and caries registration

The children were examined in Pediatric Dentistry clinic using a dental probe and a dental mirror under adequate light. Each tooth was dried with a cotton roll placed in the vestibule and cleaned thoroughly with gauze for a clear vision. No radiographs were used. For caries registration DMF(T), DMF(S), df(t) and df(s) indices according to the World Health Organization were used[25]. All caries indices were performed in one sitting by the same dentist (E.E.). A questionnaire was developed to understand the patient's overall health status, to collect demographic and socio-economic information, and to assess their oral health habits. The questionnaire consisted of three parts; the first part included questions about general health such as chronic diseases, drugs, and allergies, the second part included questions about income and education level of parents, and the last part included questions about oral health knowledge, habits and fluoride exposure. The parents were asked to fill out the questionnaire.

Cariogram was used to determine the caries risk profile from data obtained at the clinical, microbiological and biochemical tests and it has been shown to be appropriate in the caries risk assessment[26–28]. Caries risk profiles of all children were estimated using the Cariogram, which identifies three risk groups as low, medium and high caries risk according to the scores.

Taste evaluation

The taste perception level of each basic taste was assessed using a modified version from Wendin *et al.*[29]. The test followed the original method explained in the literature[23,29,30]. We formulated aqueous basic taste solutions of sucrose (Merck, Germany, purity >99,5%), sodium chloride (Sigma–Aldrich, USA, purity >99%), caffeine (Merck, Germany, purity >99,5%), and citric acid monohydrate (Sigma–Aldrich, USA, purity >99%), at low and high levels[31]. Eight solutions were prepared freshly by using spring water on the same day of measurement at room temperature (25 ± 2°C). Each solution was coded randomly and the investigator was blinded to the treatment.

All measurements of each child were accomplished at the same time of the day (between 10:00-12:00 am) by the same dentist (E.E.). Patients were advised to abstain from eating, drinking and tooth cleaning for the last 2 h before each examination. The samples were served in transparent plastic cups (50 ml) with 30 ml of a tasting solution. All samples were served in a randomized order at room temperature (approximately 24 ^{0}C).

Before testing, each child was instructed to demonstrate the ability to follow a sip-and-spit procedure by spitting tap water into a bowl. After the demonstration, all eight encoded cups were presented in front of the child, the child was told that she/he could start with a cup which she/he wanted to taste. The child selected one of the eight cups randomly, following the sip-and-spit process and the child was asked to identify the taste quality and and its intensity. The child rinsed with tap-water between tasting and was given a two-minute break to taste the next solution. All solutions were blinded to the children.

Statistical Analysis

The data were analyzed using IBM ® SPSS ® (version 24.0; IBM, Chicago, IL, USA). The mean, standard deviation, range, and frequency for variables were calculated. The Kruskal Wallis test was used to test the difference between three risks, followed by a Dunn's post-hoc test. Pearson Chi Square analysis was used for the crosstab of variables; the Spearman's Rank Correlation Test was used for the correlation between age and solution types. A p value of <0,05 was considered statistically significant.

Results

Taste perception percentage of the whole study group was the highest in sucrose solutions (86% for 12g/L and 92% for 24g/L), next two highest were in citric acid (80% for 0,6g/L and 87% for 1,20g/L) and in sodium chloride (61,5 % for 2 g/L and 76% for 4 g/L) and the lowest was in caffeine solutions (9,5% for 0,27g/L and 39% for 0,54g/L). A significant correlation was found between 2 g/L of NaCl and age (p= 0,007, r= 0,178). There was not any significant relationship between sucrose, caffeine, citric acid and age (Table 1). Also, variance analysis showed that there was not any significant difference between gender or other demographic, microbiologic, biochemical parameters and any taste perception.

Table 1. Percentages of taste perception by age and solution type

Age	6	7	8	9	10	11	12	13	total	Chi Square p value	r
n	12	28	38	21	40	31	24	6	200		
12 g/L Sucrose	75,0	75,0	86,8	81,0	92,5	90,3	91,7	83,3	86,0	0,424	0,144
24 g/L Sucrose	83,3	85,7	92,1	90,5	92,5	96,8	100	83,3	92,0	0,486	0,136
2 g/L NaCl	33,3	57,1	55,3	42,9	77,5	64,5	83.3	33,3	61,5	0,007*	0,178*
4 g/L NaCl	50,0	67,9	73,7	76,2	82,5	77,4	87.5	83,3	76,0	0,294	0,172
0,27 g/L Caffeine	25,0	7,1	10,5	14,3	5,0	9,7	8,3	0,0	9,5	0,569	-0,079
0,54 g/L Caffeine	16,7	21,4	36,8	38,1	52,5	45,2	50.0	16,7	39,0	0,092	0,170
0.6 g/L Citric acid	75,0	78,6	76,3	90,5	70,0	83,9	91.7	83,3	80,0	0,444	0,078
1,20 g/L Citric acid	91,7	82,1	89,5	85,7	82,5	90,3	91.7	83,3	87,0	0,919	0,027

Out of 200 children, mean DMF(T), DMF(S), df(t), and df(s) were 1,74±1,90, 2,14±2,67, 2,82±3,23, 5,26±6,49, respectively. DMF(T) and DMF(S) averages of the high-risk group were observed to be statistically significantly higher than the low and medium risk groups (p= 0,0001) and DMF(T) and DMF(S) averages of the middle-risk group to be higher than the low-risk group (p= 0,0001).

There was no statistically significant difference between low, middle and high-risk groups with respect to the socio-economic level, age, gender distributions, brushing frequency, oral hygiene, and fluoride use. As expected, salivary flow rate (p= 0,0001), buffer capacity (p= 0,003), *MS* counts (p= 0,0001), and LB counts (p= 0,0001) were significantly different between low, moderate and high-risk groups**.** The high-risk group's meal frequency was also found to be significantly higher than the low and middle-risk groups (p= 0,0001).

When we evaluated only occlusal or approximal caries of the children aged between 6 to 9, the Spearman's test found a weak positive correlation between occlusal caries and higher sweet taste (24 g/L sucrose) (r= 0,232; p= 0,021) and a weak negative correlation between approximal caries and higher salty taste (4 g/L NaCl) (r= –0,225; p = 0,025) (Tables 2 & 3).

Table 2. Occlusal caries and taste perceptions

Occlusal caries	No caries	1-2 caries	3 < caries	Chi Square p value	Spearman r correlation coefficient
n	31 (%)	27 (%)	41 (%)		
12 g/L Sucrose	26 (84)	21 (78)	33 (81)	0,746	-0,033
24 g/L Sucrose	23 (74)	27 (100)	38 (92)	0,021 *	0,232
2 g/L NaCl	18 (58)	13 (48)	19 (46)	0,594	-0,054
4 g/L NaCl	23 (74)	20 (74)	24 (59)	0,145	-0,147
0,27 g/L Caffeine	5 (16)	4 (15)	3 (7)	0,245	-0,117
0,54 g/L Caffeine	6 (19)	9 (33)	15 (37)	0,125	0,155
0,6 g/L Citric acid	25 (81)	24 (89)	30 (73)	0,381	-0,089
1,20 g/L Citric acid	29 (93)	22 (81)	31 (85)	0,348	-0,095

Table 3. Approximal caries and taste perception

Approximal caries n	No caries 31 (%)	1-2 caries 19 (%)	3 <caries 49 (%)	Chi Square p value	Spearman r correlation coefficient
12 g/L Sucrose	24 (77)	15 (89)	41 (84)	0,479	0,072
24 g/L Sucrose	27 (87)	18 (95)	43 (88)	1,000	0,000
2 g/L NaCl	14 (45)	10 (56)	26 (53)	0,137	-0,150
4 g/L NaCl	24 (77)	16 (84)	27 (55)	0,025 *	-0,225
0,27 g/L Caffeine	4 (13)	0 (0)	8 (16)	0,527	0,064
0,54 g/L Caffeine	8 (26)	4 (21)	18 (37)	0,261	0,113
0,6 g/L Citric acid	23 (74)	16 (84)	40 (82)	0,456	0,075
1,20 g/L Citric acid	26 (84)	17 (90)	43 (88)	0,647	0,046

Discussion

One key objective of the study was to evaluate whether sweet, salty, bitter and/or sour taste perception could be used as a caries risk assessment in children since identifying caries risk in children has been a challenge in dentistry. In order to identify the caries risk, factors such as microorganisms, host factors, bacterial plaque, socio-economic status, nutritional habits and genetics that play a role in caries etiology must be considered simultaneously[2,3,32]. In the present study, we could not find any significant difference between the perceptions of four different tastes and the caries risk groups categorized by Cariogram.

On the other hand, when we examined dental caries on different surfaces of the teeth and found that children who tasted 24 g/L of sucrose solution had higher occlusal caries and the difference was statistically significant (p= 0,021). Interestingly when we evaluated the approximal caries, we also found that a weak negative correlation existed between 4 g/L salty taste perception and approximal caries (0,025). A recent study[33] evaluated children of three different ethnic background, found a weak positive correlation between taste perception and DMF(S), whereas previous studies[34,35] did not find any significant relationship between sweet taste and dental caries. Furquim *et al.*[36] compared sweet and bitter taste and also found no correlation between sweet taste and dental caries but bitter seemed to have a negative correlation with dental caries.

The age of the child is critical when a study deals with cognitive functions of the children. It was very challenging to identify taste perception and threshold in children. As a matter of fact, we found irregularities in all taste perceptions at different age groups. We found that sweet and sour tastes are easily distinguished in our age groups. While salty taste was discriminated lesser in the lowest concentration, bitter taste was the least to perceive in the lower concentration. These high or low perceived tastes seem to lead no statistically significant difference because of the equal distribution among age groups. On the other hand, the perception of the lower concentration of the NaCl improved as the child grows[37].

Conclusions

Age should be taken into consideration in the assessment of taste perception evaluation among children. In addition, there is a weak relationship between taste perceptions and dental caries. These data suggest that further studies need to focus on the effect of taste preferences on dental caries.

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